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Dr Richard T. Carlin

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The symposium was attended by internationally recognized speakers from sixteen countries. Sixty-six papers were presented at the symposium of which fifty-four are contained in this proceedings volume. Much of the symposium centered around technological opportunities in molten salts and related materials. In keeping with this theme, Prof. Niels J. Bjerrum in his 1996 Max Bredig Award address emphasized that molten salt electrochemistry has a rich past with a bright future in numerous technologically important areas, including alloy electrodeposition, production of amorphous metals, electrosynthesis of superhard materials, electrocatalysis, and corrosion. Of course, the basis for these technological advances is derived from the fundamental understanding of molten salts provided by numerous researchers, and excellent papers were presented that provided further insight into the complexity of molten salt thermodynamics, transport properties, structure, and spectroscopy.

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Contractor's Final Report

on

Tenth International Symposium on Molten Salts

Dr. Richard T. Carlin (P.I.)
Covalent Associates, Inc.
10 State Street
Woburn MA 01801

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Abstract

The Tenth International Symposium on Molten Salts was held during the 189th Meeting of the Electrochemical Society in Los Angeles, California, May 6-10, 1996. The symposium was attended by internationally recognized speakers from sixteen countries. Sixty-six papers were presented at the symposium of which fifty-four are contained in the proceedings volume. Three copies of the proceedings volume entitled *Molten Salts X* have been sent to AFOSR to satisfy the contract requirements. The Table of Contents of the proceedings is provided on page 4 of this report.

Much of the symposium centered around technological opportunities in molten salts and related materials. In keeping with this theme, Prof. Niels J. Bjerrum in his 1996 Max Bredig Award address emphasized that molten salt electrochemistry has a rich past with a bright future in numerous technologically important areas, including alloy electrodeposition, production of amorphous metals, electrosynthesis of superhard materials, electrocatalysis, and corrosion. Of course, the basis for these technological advances is derived from the fundamental understanding of molten salts provided by numerous researchers, and excellent papers were presented that provided further insight into the complexity of molten salt thermodynamics, transport properties, structure, and spectroscopy. A summary of the Max Bredig Award address is provided on page 9 of this report.

Financial support for this symposium came from several generous sources, including the Air Force Office of Scientific Research, the Physical Electrochemistry and High Temperature Materials Divisions of the Society, the Molten Salt Committee of the Electrochemical Society of Japan, and The Petroleum Research Fund, administered by the American Chemical Society. Funds from AFOSR ($2,000) were used to supplement travel expenses for US and international distinguished speakers.

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Metals and Alloys

Batteries

Fuel Cells

Thermodynamics, Transport Properties, Structure, and Spectroscopy

Max Bredig Award Address

MOLTEN SALT ELECTROCHEMISTRY: PRESENT AND FUTURE PRIORITIES

Niels J. Bjerrum

Materials Science Group, Chemistry Department A, Technical University of Denmark, DK-2800 Lyngby, Denmark

Molten salt electrochemistry is by no means a new research area. Some of the initial experiments go back two hundred years in history (*e.g.*, electroreduction of alkali metals) and such an important metal as aluminum has been produced for more than hundred years by an electrolysis of a molten salt electrolyte (the Hall-Héroult process).

However, molten salt electrochemistry is a very dynamic scientific and industrial area of electrochemistry looking not into the past but into the future.

There are numerous important technical areas in molten salt electrochemistry. In some of these areas enough knowledge have been accumulated to develop qualitative improvement and often parameter optimization:

(*i*) *Electrochemical production of metals* is one of the most mature areas. In connection with aluminum production the main aim of developments is to obtain a higher efficiency of the process and to solve serious ecological problems.

(*ii*) *Electroplating of protective layers on metal surfaces.* The recent developments are mostly concerned with the electrodeposition of refractory metals from molten salt electrolytes. The most important problem in this technology is control of the composition of the molten electrolytes. Another problem with refractory metal electroplating can be illustrated with the help of the example of tantalum deposition. Two different crystal forms of tantalum can be obtained electrochemically: α- and β-tantalum. The deposit with the α-form has better mechanical properties than that consisting of the β-form. Therefore, the problem of the optimization of the electrolysis parameters has to be solved with allowance for this special factor.

However, the most interesting scientific results and applications are expected in the new areas of molten salt electrochemistry:

(*iii*) *Metal alloy production* is an area with a considerable potential. This technique gives a possibility to obtain, for example, the alloys of aluminum with lithium (metals with high and low melting points), or in general alloys which are difficult to make by a direct combination.

(*iv*) *Electrodeposition of amorphous metal layers* is a technique which can be realized in molten salt electrolytes and may be the background for progressive technologies for the production of highly corrosion resistant materials.

(*v*) *Electrosynthesis of superhard materials.* Many such materials can be obtained electrochemically from boron-, carbon- or nitrogen-containing melts. This could be a relatively cheap technology giving a useful modification of metal surfaces. To the same area we can add the high temperature electrochemical technologies for the improvement of surface properties of superhard materials with electroplated metal layers.

(*vi*) *High-temperature electrocatalysis* is a process in which material is consumed or produced in an electrochemical reaction on a catalyst that is an electronic conductor. Obviously, the currently most interesting and important cases in this area are the molten carbonate fuel cells. The main problem here is to obtain non-soluble and catalytically active electrode materials.

(*vii*) *Electrochemical promotion of catalysts* deals with the change of activity or selectivity of molten salt catalysts using inert electrodes. It can provide an effective management concerning quality and composition of the products of the catalytic reactions.

(*viii*) *Hot corrosion* has the possibility of becoming a very important area of molten salt electrochemistry taking into account the perspective of combustion of new types of fuels or traditional but low quality fuels. It has been proven that the most severe hot corrosion problems are caused by a thin molten salt layer on the surface of the exposed metal and therefore have an electrochemical nature. Another example where hot corrosion is important is provided by high-temperature batteries and molten carbonate fuel cells. Electrochemical techniques can be powerful tools in searching for new ways of corrosion protection.

(*ix*) *High-temperature electrochemical protection from corrosion.* Cathodic and anodic protection are well known and widely used at ambient temperatures but have not to any extent been used in connection with hot (or molten salt) corrosion. For example, in connection with fire tube corrosion in boilers at power stations electrochemical protection can be one of several possible ways of prolonging the lifetime of power-station hardware.

Budget Summary

Contract No. F49620-96-1-0157; Tenth International Symposium on Molten Salts

AFOSR Contract Award: $2,000

Allocation of AFOSR Funds for Symposium:

Travel Supplement:

US Invited Speakers (2):	$640
International Invited Speakers (3):	$900

Advance Registration:

US Invited Speakers (2):	$460
Total AFOSR Expenditures	**$2,000**